PB-239 547

TURNER RESERVOIR AND CENTRAL POND, PROVIDENCE COUNTY, RHODE ISLAND, AND BRISTOL COUNTY, MASSACHUSETTS

Pacific Northwest Environmental Research Laboratory

Prepared for:

National Environmental Research Center
Rhode Island Department of Health
Massachusetts Water Resources Commission
Rhode Island National Guard

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16. ABSTRACT
Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivded according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

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REPORT

ON

TURNER RESERVOIR AND CENTRAL POND

PROVIDENCE COUNTY, RHODE ISLAND

AND

BRISTOL COUNTY, MASSACHUSETTS

EPA REGION I

WORKING PAPER No. 29

WITH THE COOPERATION OF THE

RHODE ISLAND STATE DEPARTMENT OF HEALTH,

THE RHODE ISLAND NATIONAL GUARD,

AND THE

MASSACHUSETTS WATER RESOURCES COMMISSION

SEPTEMBER, 1974

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F O R E W O R D

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to fresh water lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Rhode Island Division of Water Supply and Pollution Control and the Massachusetts Division of Water Pollution Control for professional involvement and to the Rhode Island National Guard for conduct of the tributary sampling phase of the Survey.

Carleton A. Maine, Chief, and James W. Fester, Principal Sanitary Engineer of the Rhode Island Division of Water Supply and Pollution Control; and Thomas C. McMahon, Director, John R. Elwood, Supervisory Sanitary Engineer, Eben Chesebrough, Senior Chemist, and Peter A. Tennant, Senior Sanitary Engineer of the Massachusetts Division of Water Pollution Control provided invaluable lake documentation and counsel during the course of the Survey.

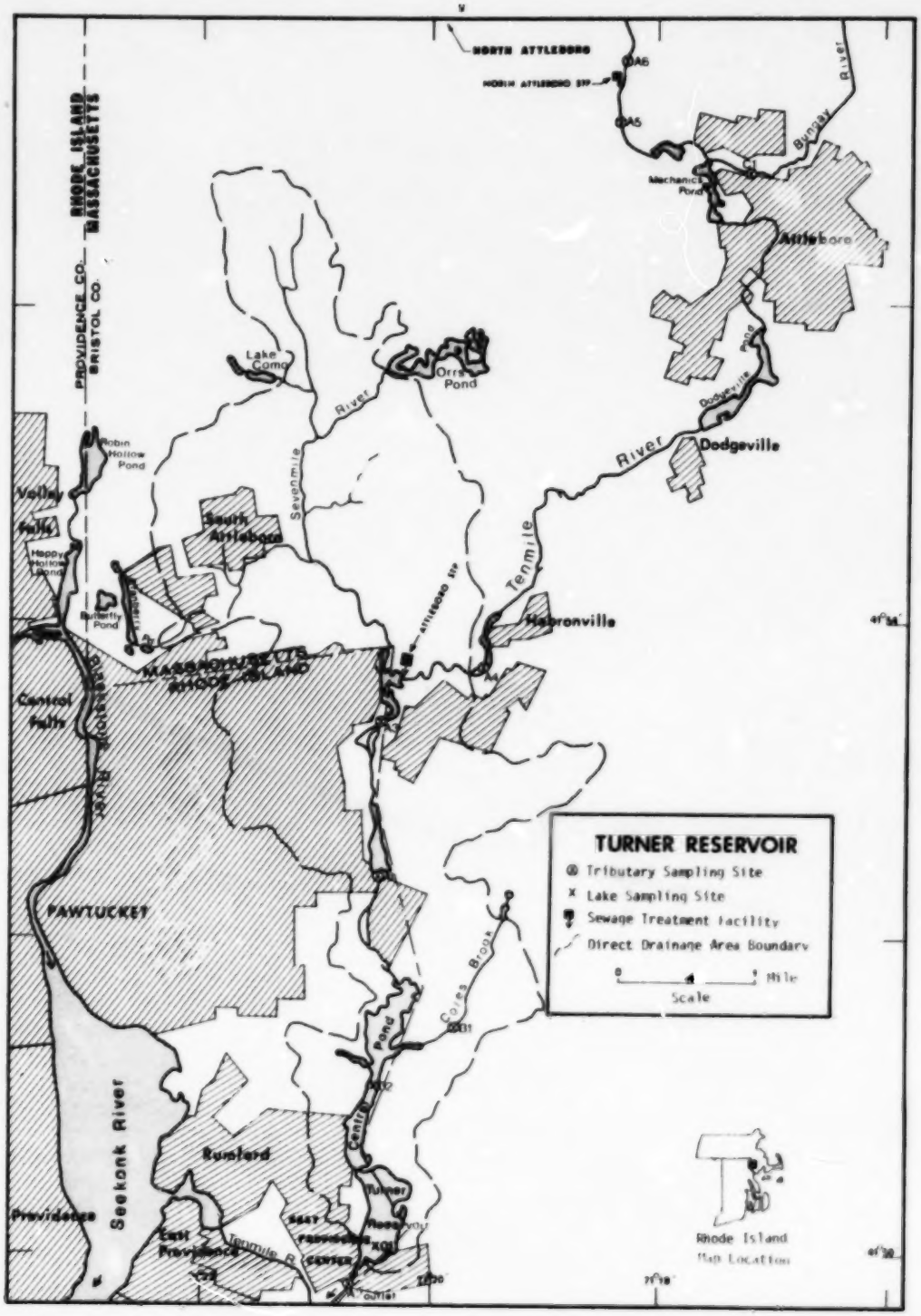
Major General Leonard Holland, the Adjutant General of Rhode Island, and Project Officer Colonel Clarence Bozar, who directed the volunteer efforts of the Rhode Island National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF RHODE ISLAND

LAKE NAME	COUNTY
Harris Pond	Providence, RI; Worchester, MA
Slatersville Reservoir	Providence, RI
Turner Reservoir	Providence, RI; Bristol, MA


RHODE ISLAND
MASSACHUSETTS
PROVIDENCE CO.
BRISTOL CO.
NORTH ATTLEBORO
NORTH ATTLEBORO STP
QA6
QA5
Bungay River
Mechanic Pond
Attleboro
Lake Como
Orrs Pond
Dodgeville Pond
Dodgeville
Robin Hollow Pond
Valley Falls
Happy Hollow Lagoon
Butterfly Pond
South Attleboro
Seventmile River
Tenmile River
Hebronville
ATTLEBORO STP
MASSACHUSETTS
RHODE ISLAND
Central Falls
Blackstone River
PAWTUCKET
Cove Brook
Cove Pond
QA31
Seekonk River
Rumford
Central Pond
Turner Reservoir
Providence
East Providence
Tenmile R.
CENTER
QA26
TURNER RESERVOIR
Tributary Sampling Site
Lake Sampling Site
Sewage Treatment Facility
Direct Drainage Area Boundary
0 1 Mile
Scale
Rhode Island
Map Location

TURNER RESERVOIR AND CENTRAL POND

STORET NO. 4403

I. CONCLUSIONS

A. Trophic Condition:

Both Turner Reservoir and Central Pond are eutrophic as evidenced by high nutrient levels, high chlorophyll a values, low Secchi disc transparencies, and depression of dissolved oxygen with depth.

B. Rate Limiting Nutrient:

The algal assay results show that the Turner Reservoir-Central Pond system was nitrogen limited at the time the assay sample was collected. Reservoir and Pond sampling data confirm this conclusion.

C. Nutrient Controllability:

1. Point sources--It is estimated that during the sampling year the Turner Reservoir-Central Pond system received a total phosphorus load at a rate about 45 times that proposed by Vollenweider (in press) as dangerous; i.e., a eutrophic rate (see page 17). It is calculated that municipal and industrial point sources contributed nearly 94% of that load.

Preliminary plans and specifications for nutrient removal at both the Attleboro and North Attleboro (Massachusetts) waste treatment facilities have been approved by the Massachusetts

Division of Water Pollution Control; and, at the time of preparation of this report, the start of construction at both places was awaiting funding. Also, the Attleboro plan includes the interception and treatment of the wastes from the Attleboro Dyeing and Finishing plant and the Dodgeville Finishing plant. The nutrient removal facilities to be constructed are designed to provide mean effluent limits of 0.5 mg/l of total phosphorus and 2.0 mg/l of soluble nitrogen. On the basis of Survey data, it is calculated that the phosphorus limits will require about 93% P removal at the Attleboro plant and about 85% P removal at the North Attleboro plant. These levels of phosphorus removal, plus elimination of the two industrial discharges, will reduce the total phosphorus loading to the Turner Reservoir-Central Pond system by about 60% (from 693 lbs/acre/yr to 271 lbs/acre/yr).

The above reduction will result in a loading rate of 30.4 g $P/m^2/yr$ (still about 18 times Vollenweider's "dangerous" rate). However, considering the lack of major aquatic nuisances with the existing loading rates, the phosphorus reduction should result in improvement in the trophic condition of the system.

2. Non-point sources--The non-point phosphorus export of (presumably) unimpacted Coles Brook (see page 17) was over four

times higher than the 50 lbs/mi^2/yr of nearby unimpacted Quick Stream (see Working Paper No. 27, "Report on Harris Pond") and indicates unknown and unmeasured point sources may have been contributing nutrients.

II. INTRODUCTION

The Turner River-Central Pond system originated with an impoundment of Tenmile River at or just upstream from the present Massachusetts State Highway 152 crossing. Some years later another dam was constructed downstream at the existing outlet of Turner Reservoir. The two water bodies are contiguous; but reportedly, they are not broadly joined (Tennant and Chesebrough, 1974).

The system served as a raw water supply for the City of East Providence until late 1970 when the City of Providence began providing potable water. At present, there is little recreational use of the system; however, the City of East Providence is in the process of developing the area for recreation.

The shoreline is largely wooded and in its natural setting. Shoreline development is restricted to a few scattered cottages on the east side.

III. LAKE AND DRAINAGE BASIN CHARACTERISTICS

A. Lake Morphometry*:

1. TURNER RESERVOIR-CENTRAL POND SYSTEM -
   a. Surface area: 256 acres.
   b. Mean depth: 5 feet.
   c. Maximum depth: 10 feet.
   d. Volume: 1,280 acre/feet.
   e. Mean hydraulic retention time: 6.9 days.
2. TURNER RESERVOIR -
   a. Surface area: 122 acres.
   b. Mean depth: 5 feet.
   c. Maximum depth: 10 feet.
   d. Volume: 610 acre/feet.
   e. Mean hydraulic retention time: 3.3 days.
3. CENTRAL POND -
   a. Surface area: 134 acres.
   b. Mean depth: 5 feet.
   c. Maximum depth: 10 feet.
   d. Volume: 670 acre/feet.
   e. Mean hydraulic retention time: 3.6 days.

---

* Anonymous, 1970.

B. Tributary and Outlet:
(See Appendix A for flow data)

1. Tributaries -

Name	Drainage area*	Mean flow*
Tenmile River	44.4 mi^2	77.4 cfs
Coles Brook	3.1 mi^2	5.5 cfs
Minor tributaries & immediate drainage -	5.6 mi^2	10.5 cfs
Totals	53.1 mi^2	93.4 cfs

2. Outlet -

Tenmile River	53.5 mi^2**	93.4 cfs

C. Precipitation†:

1. Year of sampling: 59.1 inches.

2. Mean annual: 42.1 inches.

* Drainage areas are accurate within ±1%; gaged flows are accurate within ±15%; and ungaged flows are accurate within ±20%.
** Includes area of Turner-Central system.
† See Working Paper No. 1, "Survey Methods".

IV. LAKE WATER QUALITY SUMMARY

Turner Reservoir and Central Pond were each sampled three times during the open-water season of 1972 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from a single station on each water body and from one or more depths (see map, page v). During each visit, a single depth-integrated (near bottom to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the last visit, a single five-gallon depth-integrated sample was composited from the two water bodies for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll a analysis. The maximum depth sampled was 5 feet in Turner Reservoir and 4 feet in Central Pond.

Although the two water bodies are contiguous, they are not broadly joined, and there are significant differences in various parameters both in levels and patterns (e.g., D.O., conductivity, and nutrients). Therefore, summaries of data for the fall sampling period (when both water bodies were well-mixed) are provided. The data are presented in full in Appendix B.

A. Physical and chemical characteristics:

1. TURNER RESERVOIR -

Parameter	Minimum	FALL VALUES (10/06/72) Mean	Median	Maximum
Temperature (Cent.)		(not measured)		
Dissolved oxygen (mg/l)		(not measured)		
Conductivity (μmhos)	260	260	260	260
pH (units)	6.8	6.8	6.8	6.8
Alkalinity (mg/l)	26	27	27	27
Total P (mg/l)	0.800	0.850	0.850	0.900
Dissolved P (mg/l)	0.610	0.635	0.635	0.660
NO_2 + NO_3 (mg/l)	0.820	0.825	0.825	0.830
Ammonia (mg/l)	0.690	0.710	0.710	0.730
		ALL VALUES		
Secchi disc (inches)	30	30	30	30

2. CENTRAL POND -

Parameter	Minimum	FALL VALUES (10/06/72) Mean	Median	Maximum
Temperature	16.8	16.8	16.8	16.8
Dissolved oxygen	3.4	3.4	3.4	3.4
Conductivity	335	338	338	340
pH	6.5	6.6	6.6	6.6
Alkalinity	39	39	39	39
Total P	1.370	1.380	1.380	1.390
Dissolved P	1.080	1.095	1.095	1.110
NO_2 + NO_3	1.180	1.260	1.260	1.340
Ammonia	1.850	1.890	1.890	1.930
		ALL VALUES		
Secchi disc	27	27	27	27

B. Biological characteristics:

1. Phytoplankton* -

Sampling Date	Dominant Genera	Number per ml
08/01/72	1. Dictyosphaerium	1,446
	2. Cyclotella	1,386
	3. Synedra	316
	4. Microcystis	211
	5. Flagellates	196
	Other genera	1,445
	Total	5,000
10/06/72	1. Melosira	1,940
	2. Synedra	678
	3. Scenedesmus	339
	4. Chroococcus	245
	5. Navicula	188
	Other genera	1,130
	Total	4,520

2. Chlorophyll a -
(Because of instrumentation problems during the 1972 sampling, the following values may be in error by plus or minus 20 percent.)

Sampling Date	Station Number	Chlorophyll a (µg/l)
06/04/72	01**	12.0
	02***	15.9
08/01/72	01	46.7
	02	51.7
10/06/72	01	7.5
	02	3.7

* The June phytoplankton sample was lost in shipment.
** Turner Reservoir.
*** Central Pond.

C. Limiting Nutrient Study (combined Turner Reservoir-Central Pond sample):

1. Autoclaved, filtered, and nutrient spiked -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.560	1.600	38.1
0.006 P	0.566	1.600	48.9
0.012 P	0.572	1.600	40.0
0.024 P	0.584	1.600	41.3
0.060 P	0.620	1.600	35.2
0.060 P + 10.0 N	0.620	1.600	274.2
10.0 N	0.560	11.600	197.0

2. Discussion -

The control yield of the assay alga, Selenastrum capricornutum, indicates that the potential primary productivity of the Turner Reservoir-Central Pond system was very high at the time the combined assay sample was collected. Also, the lack of significant change in yields with increased levels of orhtophosphorus until nitrogen was also added shows that the system was nitrogen limited when sampled. Note that the addition of only nitrogen resulted in a yield far greater than the control yield.

Nitrogen limitation is also indicated by the data for each of the water bodies at each sampling time; i.e., nitrogen to phosphorus ratios were less than 2 to 1 on all occasions.

D. Trophic Condition:

Both Turner Reservoir and Central Pond are eutrophic as evidenced by high nutrient levels, high chlorophyll *a* values, low Secchi disc transparencies, and depression of oxygen with depth. Also, the algal assay showed that the potential primary productivity of the system was very high.

Despite extremely high nutrient loading rates, neither water body is noted for the occurrence of nuisance aquatic growths, although taste and odor problems caused by algae were common when the system served as the raw water supply for the City of East Providence, RI. Rooted aquatic vegetation is common in both water bodies but reportedly does not constitute a problem except in small isolated areas.

V. NUTRIENT LOADINGS
(See Appendix C for data)

For the determination of nutrient loadings, the Rhode Island National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page v), except for the high runoff months of March and April when two samples were collected. Sampling was begun in August, 1972, and was completed in July, 1973.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the New England District Office of the U.S. Geological Survey for the tributary sites nearest the lake.

Nutrient loads for Coles Brook were calculated using mean annual concentrations and the mean annual flow. However, the sum of the estimated point-source phosphorus loads exceeded the phosphorus load measured in the Tenmile River at the inlet sampling station (A-1); and the Tenmile River non-point phosphorus load was estimated using the Coles Brook load, in $lbs/mi^2/yr$, and multiplying by the Tenmile River drainage area in mi^2. Note, however, the nitrogen load is that measured at station A-1 minus the estimated point-source loads.

Nutrient loadings for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated by using the mean annual concentrations in Coles Brook at station B-1 and the mean annual ZZ flow.

Discharges from the Attleboro and North Attleboro (Massachusetts) wastewater treatment plants were sampled by the operators on a monthly basis, and influent flow data were provided. With regard to flows, personnel of the Massachusetts Division of Water Pollution Control (Tennant and Chesebrough, 1974) advise that effluent flows of the Attleboro plant may be as little as one-third of the corresponding influent flows because of evaporation from and seepage through the rather old but sizable sand filters. Because of this, nutrient loads attributed to Attleboro were estimated on the basis of information provided by Tennant and Chesebrough (op. cit.).

Also, industrial wastes were not sampled during the Survey but contribute significant amounts of nutrients in the drainage. In the following loading tables, the nutrient loads given for industrial sources are based on data also provided by Tennant and Chesebrough.

A. Waste Sources:

1. Known municipal -

Name	Pop. Served*	Treatment	Mean Flow (mgd)	Receiving Water
Attleboro	29,000	sand filters	3.800	Tenmile River
North Attleboro	15,800	sand filters	2.660	Tenmile River

2. Known industrial** -

Name	Receiving Water
Attleboro Dyeing & Finishing Co., Seekonk Township	Tenmile River
Dodgeville Finishing Co., Attleboro	Tenmile River
Technor Apex Co., Hebronville	Tenvile River
Various plating & jewelry plants, Plainville and North Attleboro townships and City of Attleboro	Tenmile River

* Estimated; see Working Paper No. 1.
** Tennant and Chesebrough, 1974.

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	lbs P/ yr	% of total
a. Tributaries (non-point load) -		
Tenmile River	9,150	5.2
Coles Brook	640	0.4
b. Minor tributaries & immediate drainage (non-point load) -	1,220	0.7
c. Known municipal STP's -		
Attleboro	40,000	22.5
North Attleboro	26,440	14.9
d. Septic tanks - Unknown	-	-
e. Known industrial -		
Attleboro Dyeing & Finishing	40,000	22.5
Dodgeville Finishing	12,000	6.8
Technor Apex	?	-
Various plating & jewelry	48,000	27.0
f. Direct precipitation* -	40	<0.1
Total	177,490	100.0

2. Outputs -

Lake outlet - Tenmile River 117,860

3. Net annual P accumulation - 59,630 pounds

* Estimated; see Working Paper No. 1.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	lbs N/ yr	% of total
a. Tributaries (non-point load) -		
Tenmile River	150,430	30.7
Coles Brook	12,780	2.6
b. Minor tributaries & immediate drainage (non-point load) -	24,390	5.0
c. Known municipal STP's -		
Attleboro	120,000	24.5
North Attleboro	97,180	19.8
d. Septic tanks - Unknown	-	-
e. Known industrial -		
Attleboro Dyeing & Finishing	58,000	11.8
Dodgeville Finishing	17,000	3.5
Technor Apex	7,500	1.6
Various plating & jewelry	?	-
f. Direct precipitation* -	2,470	0.5
Total	489,750	100.0

2. Outputs -

Lake outlet - Tenmile River 473,830

3. Net annual N accumulation - 15,920 pounds

* Estimated; see Working Paper No. 1.

D. Mean Annual Non-point Nutrient Export by Subdrainage Area:

Tributary	lbs $P/mi^2/yr$	lbs $N/mi^2/yr$
Coles Brook	206	4,123

E. Yearly Loading Rates:

In the following table, the existing phosphorus loading rates are compared to those proposed by Vollenweider (in press). Essentially, his "dangerous" rate is the rate at which the receiving waters would become eutrophic or remain eutrophic; his "permissible" rate is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic rate would be considered one between "dangerous" and "permissible".

	Total Phosphorus		Total Nitrogen	
Units	Total	Accumulated	Total	Accumulated
lbs/acre/yr	693.3	232.9	1,913.1	62.2
grams/m^2/yr	77.71	26.11	214.4	7.0

Vollenweider loading rates for phosphorus ($g/m^2/yr$) based on mean depth and mean hydraulic retention time of Turner Reservoir-Central Pond system:

"Dangerous" (eutrophic rate)	1.72
"Permissible" (oligotrophic rate)	0.86

VI. LITERATURE REVIEWED

Anonymous, 1970. Rhode Island lakes and ponds. RI Water Resources Board, Providence.

Fester, James W., 1973. Personal communication (characteristics of Turner Reservoir-Central Pond system; uses of system; trophic condition). RI Divn. Water Supply & Pollution Control, Providence.

Tennant, Peter A., 1973. Personal communication (characteristics of Tenmile River drainage; previous studies; characteristics of Turner Reservoir-Central Pond system; nutrient removal requirements). MA Divn. Water Pollution Control, Westborough.

_____, and Eben Chesebrough, 1974. Personal communication (review of Survey reports). RI Divn. Water Pollution Control, Westborough.

Vollenweider, Richard A., (in press). Input-output models. Schweiz A. Hydrol.

TRIBUTARY FLOW INFORMATION FOR RHODE ISLAND 7/9/74

LAKE CODE 4403 TURNER RESERVOIR

TOTAL DRAINAGE AREA OF LAKE 53.50

TRIBUTARY	SUB-DRAINAGE AREA	NORMALIZED FLOWS JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
440381	44.40	96.80	111.30	159.00	140.00	93.70	51.90	25.60	26.40	33.30	38.20	67.50	87.50	77.35
440382	53.50	117.00	133.00	192.00	169.00	113.00	62.60	30.80	31.80	40.10	46.10	81.30	105.00	93.21
440341	3.14	6.83	7.80	11.20	9.90	6.60	3.70	1.80	1.90	2.40	2.70	4.80	6.20	5.47
440322	6.60	13.10	14.60	21.50	19.00	12.70	7.00	3.50	3.60	4.50	5.20	9.10	11.80	10.46

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 53.50
SUM OF SUB-DRAINAGE AREAS = 53.54
TOTAL FLOW IN = 1122.60
TOTAL FLOW OUT = 1121.70

MEAN MONTHLY FLOWS AND DAILY FLOWS

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
440381	8	72	33.80	30	24.40				
	9	72	41.60	10	27.80				
	10	72	84.30						
	11	72	232.00	5	74.10	11	268.00		
	12	72	243.00	3	244.00				
	1	73	168.00	30	153.00				
	2	73	148.00	3	852.00				
	3	73	105.00	4	97.70	26	87.00		
	4	73	148.00	8	179.00	19	106.00		
	5	73	113.00	5	120.00	31	67.50		
	6	73	55.50						
	7	73	65.50	2	218.00				
440382	8	72	40.70	30	29.40				
	9	72	50.10	10	33.50				
	10	72	102.00						
	11	72	279.50	5	94.20	11	323.00		
	12	72	352.00	3	294.00				
	1	73	205.00	30	185.00				
	2	73	225.00	3	1027.00				
	3	73	127.00	4	115.00	27	126.00		
	4	73	226.00	4	216.00	19	128.00		
	5	73	137.00	5	145.00	31	81.30		
	6	73	67.00						
	7	73	78.40	2	262.00				

TRIBUTARY FLOW INFORMATION FOR RHODE ISLAND 7/9/74

LAKE CODE 4403 TIVERTON RESERVOIR

MEAN MONTHLY FLOWS AND DAILY FLOWS

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
440381	8	72	2.40	30	1.70				
	9	72	3.00	10	2.00				
	10	72	6.00						
	11	72	16.50	5	5.50	11	19.00		
	12	72	20.80	3	17.20				
	1	73	11.90	30	10.80				
	2	73	13.20	3	60.30				
	3	73	7.40	4	6.90	27	7.40		
	4	73	13.30	8	12.70	19	7.50		
	5	73	8.00	5	8.50	31	4.80		
	6	73	4.00						
	7	73	4.60	2	15.40				
440321	8	72	4.60						
	9	72	5.60						
	10	72	11.50						
	11	72	31.20						
	12	72	39.50						
	1	73	22.90						
	2	73	25.20						
	3	73	14.20						
	4	73	25.50						
	5	73	15.40						
	6	73	7.50						
	7	73	9.60						

APPENDIX B

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 74/07/02

441301
41 50 00.0 071 20 30.0
TURNER RESERVOIR
44 RHODE ISLAND

1IFPALES 2111202
4 0004 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/06/04	16 10	0000	20.8	4.0	31	220	6.70	27	0.430	1.700	1.040	0.840
72/08/01	16 35	0000			36	220	6.50	27	0.700	0.520	0.810	0.520
	16 35	0004	24.2	5.2		230	6.50	27	0.690	0.440	0.800	0.510
72/10/06	14 45	0000			30	260	6.80	27	0.830	0.690	0.900	0.660
	14 45	0005						26	0.820	0.730	0.809	0.610

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/06/04	16 10	0000	12.0J
72/08/01	16 35	0000	46.7J
72/10/06	14 45	0000	7.5J

J VALUE KNOWN TO BE IN ERROR

22

STORET RETRIEVAL DATE 74/07/02

440302
41 51 00.0 071 26 00.0
TURNER RESERVOIR
44 RHODE ISLAND

11EPALES
4

2111202
0006 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/06/04	16 25	0000	21.9	8.6		220	6.70	27	0.440	1.500	0.990	0.690
72/08/01	16 55	0000			30	200	6.50	23	0.830	0.580	0.752	0.509
	16 55	0004	21.2	4.6		180	6.30	19	0.760	0.560	0.938	0.413
72/10/06	15 00	0000			27	340	6.55	39	1.180	1.850	1.390	1.040
	15 00	0004	16.8	3.4		335	6.60	39	1.340	1.930	1.370	1.110

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/06/04	16 25	0000	15.9J
72/08/01	16 55	0000	51.7J
72/10/06	15 00	0000	3.7J

J VALUE KNOWN TO BE IN ERROR

APPENDIX C

TRIBUTARY and WASTEWATER TREATMENT PLANT DATA

STORET RETRIEVAL DATE 74/07/02

4403A1 LS4403A1
41 52 30.0 071 20 30.0
TEN-MILE RIVER
44127 7.5 E PROVIDENCE
1/TURNER RESERVOIR
CENTRAL AVE BRDG W EDGE OF GOLF CLUB
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/08/26	10	20	0.227	4.200	1.000L	1.600	1.900
72/09/10	12	15	0.751	2.350	1.030	0.330	0.630
72/11/05	08	20	0.590	2.100	0.021	0.400	0.830
72/11/11	14	00	0.561	1.470	0.550	0.318	0.520
72/12/03	15	20	0.700	1.320	0.620	0.290	0.431
73/01/30	15	00	0.880	1.800	1.100	0.340	0.550
73/02/03	10	45	0.550	1.320	0.540	0.083	0.340
73/03/04	10	30	0.880	2.200	1.400	0.500	0.750
73/03/26	14	40	0.840	2.800	1.500	0.500	0.780
73/04/08	14	00	0.570	1.540	0.690	0.310	0.525
73/04/19			0.850	2.100	0.805	0.635	0.945
73/05/31	13	45	0.600	2.500	0.890	0.770	1.100
73/07/02	13	40	0.700	4.000	1.680	1.260	1.800

STORET RETRIEVAL DATE 74/07/02

4403A2 LS4403A2
41 50 00.0 071 21 00.0
TEN-MILE RIVER
44 7.5 E PROVIDENCE
O/TURNER RESERVOIR
ST HWY BRDG 114A
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/08/26	09 40		0.442	1.445	0.138	0.487	0.520
72/09/10	12 20		0.555	1.750	0.176	0.200	0.330
72/11/05	08 30		0.770	1.800	0.027	0.310	0.820
72/11/11	13 30		0.530	1.550	0.480	0.270	0.450
73/01/30	15 15		0.960	2.100	1.020	0.420	0.600
73/02/03	11 00		0.760	1.470	0.720	0.280	0.460
73/03/04	11 00		0.810	1.800	0.810	0.410	0.650
73/03/27	11 40		0.870	2.100	1.200	0.590	0.810
73/04/08	14 00		0.670	1.320	0.530	0.320	0.520
73/04/19			0.490	3.990	1.580	0.650	1.000
73/05/05	13 00		0.650	1.380	0.360	0.357	0.540
73/07/02	13 25		0.399	2.310	0.440	0.820	0.990

STORET RETRIEVAL DATE 74/07/02

4403A3 LS4403A3
41 53 30.0 071 20 30.0
TEN-MILE RIVER
44 7.5 ATTLEBORO MA
I/TURNER RESERVOIR
CENTRAL AVE BRDG BELO ATTLEBORO MA STP
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/08/26	10 35		0.482	3.890	1.000L	1.400	1.900
72/09/10	11 45		0.840	2.550	1.100	0.145	0.480
72/11/05	08 30		0.610	2.050	0.025	0.310	0.800
72/11/11	13 00		0.540	1.720	0.640	0.330	0.510
72/12/03	15 00		0.580	1.300	0.520	0.280	0.386
73/01/30	13 45		0.740	2.100	0.740	0.270	0.425
73/02/03	10 00		0.570	1.200	0.490	0.075	0.300
73/03/04	10 00		0.870	2.200	1.300	0.520	0.780
73/03/26	14 30		0.780	3.000	1.580	0.610	0.910
73/04/08	14 10		0.530	1.470	0.680	0.310	0.500
73/04/19			0.710	2.200	0.860	0.780	1.050
73/05/05	13 40		0.610	2.200	0.860	0.620	0.945
73/07/02	12 50		0.710	4.400	1.470	1.000	1.400

STORET RETRIEVAL DATE 74/07/02

4403A4 LS4403A4
41 54 00.0 071 19 30.0
TEN-MILE RIVER
44 7.5 ATTLEBORO MA
I/TURNER RESERVOIR
POND ST BRDG ABOVE ATTLEBORO STP
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/08/26	10 42		0.367	2.425	0.198	0.840	1.370
72/09/10	11 58		0.787	1.350	0.374	0.170	0.315
72/11/05	08 05		0.560	1.600	0.029	0.390	0.710
72/11/11	13 45		0.470	0.945	0.300	0.294	0.460
72/12/03	15 00		0.530	1.150	0.310	0.231	0.340
73/01/30	13 55		0.600	1.300	0.460	0.189	0.370
73/02/03	10 14		0.490	1.000	0.420	0.078	0.330
73/03/03	10 35		0.740	1.440	0.760	0.399	0.620
73/03/23	10 00		0.820	1.470	0.690	0.830	1.130
73/04/08	14 20		0.460	1.100	0.357	0.240	0.420
73/04/19			0.510	1.400	0.350	0.410	0.700
73/05/05	14 00		0.730	1.540	0.470	0.300	0.620
73/05/31	13 00		0.510	1.520	0.460	0.430	0.690
73/07/02	13 10		0.720	2.300	0.570	0.850	1.350

STORET RETRIEVAL DATE 74/07/02

4403A5 LS4403A5
41 57 30.0 071 18 30.0
TEN-MILE RIVER
44 7.5 ATTLEBORO MA
I/TURNER RESERVOIR
US 295 BRDG JUST BELO N ATTLEBORO MA STP
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/08/26	11 20		0.385	6.600	1.000L	0.880	1.200
72/09/10	12 20		0.507	4.420	2.450	0.110	0.345
72/11/05	09 50		0.420	2.350	0.018	0.370	0.710
72/11/11	15 10		0.420	1.850	0.960	0.375	0.870
72/12/07	08 55		0.610	1.150	0.220	0.200	0.308
73/01/21	15 15		0.700	3.300	1.790	0.170	1.150
73/02/03	10 45		0.630	1.470	0.550	0.115	0.380
73/03/05	10 00		0.700	1.980	0.620	0.336	0.510
73/03/23	13 30		0.550	3.300	1.890	1.040	1.400
73/04/08	14 00		0.530	2.800	1.370	0.530	0.770
73/04/19			0.530	1.600	0.350	0.400	0.690
73/05/05	14 30		0.150	1.050	0.038	0.154	0.290
73/05/31	14 05		0.168	3.700	1.700	0.620	1.050
73/07/02	12 25		0.168	4.800	3.100	0.850	1.150

STORET RETRIEVAL DATE 74/07/02

4403A6 LS4403A6
41 57 30.0 071 18 30.0
TEN-MILE RIVER
44 7.5 ATTLEBORO MA
1/TURNER RESERVOIR
BRDG JUST ABOVE N ATTLEBORO STP
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/08/26	11 35		0.380	0.700	0.220	0.170	0.260
72/09/10	12 30		0.368	0.900	0.120	0.205	0.350
72/11/05	09 08		0.324	1.250	0.018	0.378	0.550
72/11/11	15 15		0.340	1.100	0.390	0.360	0.520
72/12/07	09 00		0.600	0.820	0.138	0.180	0.257
73/01/21	15 00		0.800	0.710	0.260	0.155	0.230
73/02/03	10 50		0.590	2.600	0.270	0.096	0.315
73/03/05	10 15		0.710	1.200	0.147	0.220	0.375
73/03/23	13 45		0.650	0.690	0.147	0.251	0.315
73/04/08	13 45		0.510	1.050		0.273	0.490
73/04/19			0.690	2.100	0.910	0.780	1.050
73/05/05	14 30		0.154	0.960	0.073	0.154	0.300
73/07/02	12 15		0.132	0.945	0.126	0.270	0.390

30

STORET RETRIEVAL DATE 74/07/02

440381 LS440381
41 51 30.0 071 20 00.0
COLES BROOK
44 7.5 E PROVIDENCE
T/TURNER RESERVOIR
ST HWY 152 BRDG
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/08/26	10 10		0.460	1.100	0.130	0.012	0.059
72/09/10	12 00		0.530	0.800	0.220	0.021	0.066
72/11/05	08 15		0.236	0.700	0.178	0.024	0.046
72/11/11	13 40		0.182	0.895	0.093	0.014	0.032
72/12/03	16 00		0.370	0.770	0.050	0.017	0.021
73/01/30	15 30		0.390	0.500	0.075	0.012	0.020
73/02/03	12 00		0.140	0.620	0.050	0.016	0.045
73/03/04	11 00		0.357	1.400	0.160	0.044	0.205
73/03/27	11 50		0.320	0.480	0.060	0.012	0.032
73/04/08	14 00		0.270	0.740	0.150	0.006	0.030
73/04/19			0.690		1.500	0.520	
73/05/05	13 10		0.260	0.740	0.084	0.024	0.065
73/05/31	14 40		0.210	0.880	0.052	0.023	0.030
73/07/02	13 50		0.290	1.700	0.180	0.070	0.120

STORET RETRIEVAL DATE 74/07/02

4403C1 LS4403C1
41 57 00.0 071 17 30.0
BUNGAY RIVER
44 7.5 ATTLEBORO MA
T/TURNER RESERVOIR
MA ST HWY 152 BRDG IN ATTLEBORO
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/08/26	11 00		0.238	0.500	0.147	0.033	0.138
72/09/10	12 11		0.450	0.600	0.200	0.038	0.093
72/11/05	08 30		0.240	0.550	0.126	0.033	0.063
72/11/11	14 00		0.073	0.690	0.083	0.024	0.044
72/12/03	15 15		0.138	0.460	0.024	0.010	0.022
73/01/21	15 30		0.360	0.350	0.054	0.016	0.025
73/02/03	10 30		0.189	0.450	0.025	0.011	0.025
73/03/03	10 05		0.336	0.360	0.063	0.013	0.030
73/03/23	10 00		0.370	0.460	0.044	0.023	0.030
73/04/08	14 15		0.088	0.560	0.022	0.022	0.030
73/04/19			0.160	0.520	0.070	0.027	0.040
73/05/05	14 00		0.078	1.030	0.064	0.032	0.067
73/05/31	15 00		0.160	1.200	0.126	0.044	0.820
73/07/02	15 10		0.098	0.910	0.170	0.077	0.140

STORET RETRIEVAL DATE 74/07/02

440350 SF440350 P017100
41 52 30.0 071 20 30.0
ATTLEBORO
44127 7.5 ATTLEBORO
T/TURNER RI RES.
TENMILE RIVER
11EPALES 2141204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
72/12/31	11 00		0.860	10.000	6.600	5.912		5.000	5.500
CP(T)- 72/12/31	16 00								
73/02/28	11 00		0.105	18.000	9.000	5.800	6.600	3.700	4.100
CP(T)- 73/02/28	16 00								
73/03/31	11 00		0.150	16.000	9.100	4.300	5.000	3.600	3.700
CP(T)- 73/03/31	16 00								
73/04/30	10 00		0.120	15.000	6.100	6.700	7.500	4.700	4.000
CP(T)- 73/04/30	16 00								
73/05/31	11 00		0.266	19.000	7.860	5.870	6.600	3.600	3.800
CP(T)- 73/05/31	16 00								
73/06/30	11 00		0.300	24.000	7.900	6.000	6.900	3.200	3.400
CP(T)- 73/06/30	16 00								
73/09/30	10 00		0.150	15.900	10.300	9.200	9.900	1.200	3.900
CP(T)- 73/09/30	16 00								
73/10/31	11 00		0.070	19.500	7.600	7.300	8.200	2.000	1.200
CP(T)- 73/10/31	15 00								
73/12/31	11 00		0.440	12.800	5.400	4.000	5.200	4.300	4.700
CP(T)- 73/12/31	16 00								

STORET RETRIEVAL DATE 74/07/02

440351 SF440351 P007800
41 57 30.0 071 18 30.0
NORTH ATTLEBORO
44 7.5 ATTLEBORO
T/TURNER RI RES.
TENMILE RIVER
11FPALES 2141204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
72/11/30	07 00								
CP(T)-			0.561	8.800	1.790	1.680	2.400	3.330	3.000
72/11/30	18 00								
73/01/02	06 00								
CP(T)-			0.610	7.200	1.900	1.720	2.600	3.400	3.200
73/01/02	18 00								
73/01/31	06 00								
CP(T)-			0.510	8.500	2.940	1.890	2.800	3.200	2.980
73/01/31	18 00								
73/02/28	07 00								
CP(T)-			0.430	11.500	4.100	2.200	3.350	2.500	2.900
73/02/28	18 00								
73/03/30	07 00								
CP(T)-			0.315	12.600	4.300	2.600	3.900	2.400	2.600
73/03/30	18 00								
73/04/30	06 00								
CP(T)-			0.595	10.500	5.400	1.500	2.300	2.600	2.800
73/04/30	17 00								
73/05/31	06 00								
CP(T)-			0.360	12.600	4.500	2.300	3.200	2.700	2.580
73/05/31	18 00								
73/07/03	06 00								
CP(T)-			0.720	12.600	5.300	2.560	3.750	2.500	2.300
73/07/03	18 00								
73/07/31	07 00								
CP(T)-			0.260	17.600	6.000	2.520	3.600	2.100	2.240
73/07/31	18 00								
73/09/04	06 00								
CP(T)-				14.000		3.840	5.100	2.100	2.100
73/09/04	17 00								
73/10/01	06 00								
CP(T)-			0.170	17.000	5.000	3.780	5.200	2.200	2.260
73/10/01	18 00								
73/10/31	06 00								
CP(T)-			0.920	12.500	4.600	2.100	2.900	2.100	2.400
73/10/31	17 00								